

TEST REPORT

OF

FCC Part 15 Subpart C §15.209, §15.231
FCC ID: TQ8-FOB-4F10

Equipment Under Test : Remote Keyless Entry

Model Name : FOB-4F10

Applicant : Hyundai Mobis Co., Ltd.

Manufacturer : ALPS Electric Korea Co., Ltd.

Date of Test(s) : 2015.08.28 ~ 2015.09.02

Date of Issue : 2015.09.04

In the configuration tested, the EUT complied with the standards specified above.

Tested By:


Jungmin Yang

Date:

2015.09.04

Approved By:


Hyunchae You

Date:

2015.09.04

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 435-837

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.

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1.2. Details of applicant

Applicant : Hyundai Mobis Co., Ltd.

Address : 203, Teheran-ro, Gangnam-gu, Seoul, 135-977 Republic of Korea

Contact Person : Choi, Seung-Hoon

Phone No. : +82 31 260 0098

1.3. Description of EUT

Kind of Product	Remote Keyless Entry
Model Name	FOB-4F10
Power Supply	DC 3.0 V (Lithium type of battery)
Frequency Range	Tx: 433.92 MHz, Rx: 125.00 kHz
Modulation Type	FSK
Number of Channels	1
Antenna Type	PCB Antenna

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1.4. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal Date	Cal Interval	Cal Due.
Spectrum Analyzer	Agilent	N9020A	MY53421758	Nov. 04, 2014	Annual	Nov. 04, 2015
Spectrum Analyzer	R&S	FSV30	103210	Dec. 29, 2014	Annual	Dec. 29, 2015
DC power Supply	Agilent	U8002A	MY48490027	Dec. 22, 2014	Annual	Dec. 22, 2015
Preamplifier	H.P.	8447F	2944A03909	Aug. 27, 2015	Annual	Aug. 27, 2016
Preamplifier	R&S	SCU 18	10117	Apr. 10, 2015	Annual	Apr. 10, 2016
High Pass Filter	Mini-Circuits	NHP-800+	VUU16801113-2	Jun. 23, 2015	Annual	Jun. 23, 2016
High Pass Filter	Wainwright Instrument GmbH	WHK3.0/18G-6SS	4	Jun. 23, 2015	Annual	Jun. 23, 2016
EMI Test Receiver	R&S	ESU26	100109	Mar. 03, 2015	Annual	Mar. 03, 2016
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 19, 2015	Biennial	Aug. 19, 2017
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB9163	396	Jun. 18, 2015	Biennial	Jun. 18, 2017
Horn Antenna	R&S	HF906	100326	Dec. 10, 2013	Biennial	Dec. 10, 2015
Antenna Master	INN-CO	MM4000	N/A	N.C.R.	N/A	N.C.R.
Turn Table	INN-CO	DS 1200S	N/A	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N.C.R.	N/A	N.C.R.

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1.5. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part 15 Subpart C §15.209, §15.231		
Section	Test Item	Result
15.209(a) 15.231(b)	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied
15.231(c)	Bandwidth of Operation Frequency	Complied
15.231(a)	Transmission Time	Complied

1.6. Test Report Revision

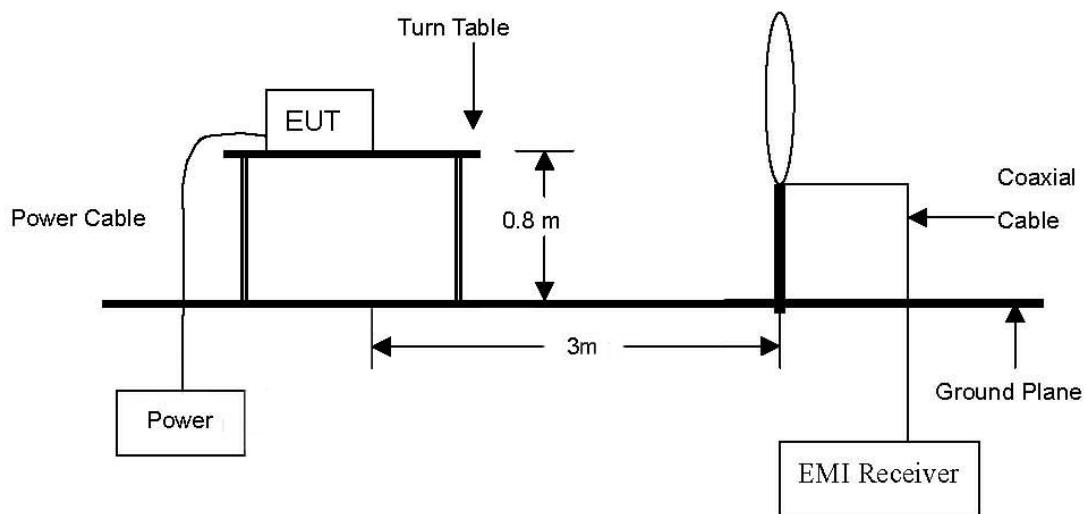
Revision	Report number	Date of issue	Description
0	F690501/RF-RTL009095	2015.09.04	Initial

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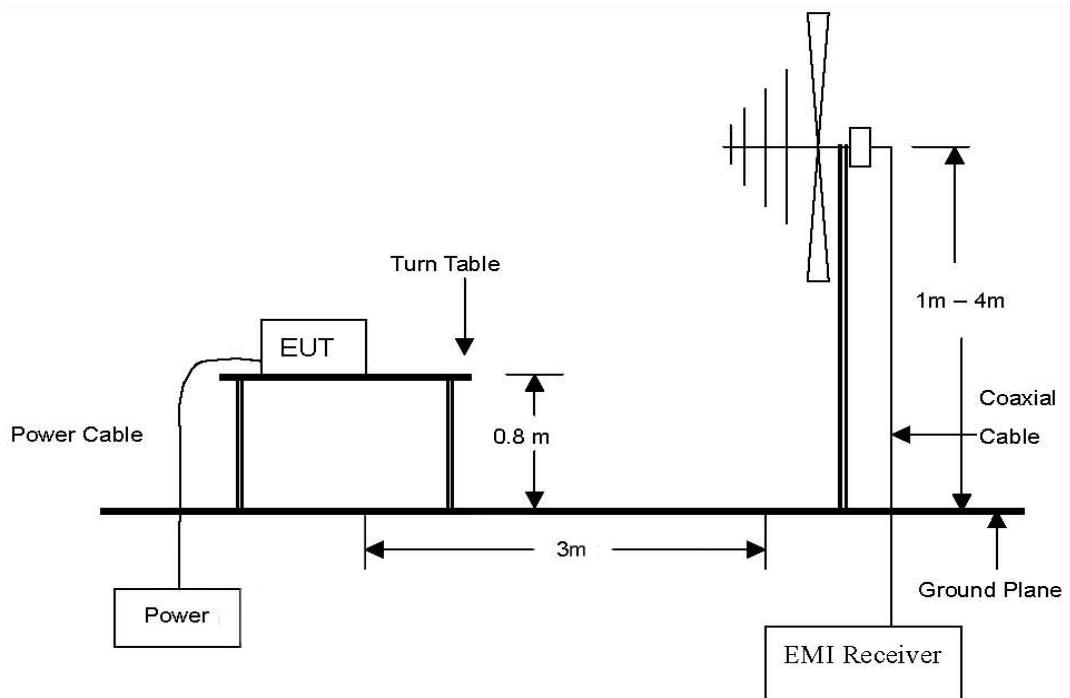
2. Field Strength of Fundamental

2.1. Test Setup

The diagram below shows the test setup that is utilized to make the measurements for emission below 30 MHz Emissions.

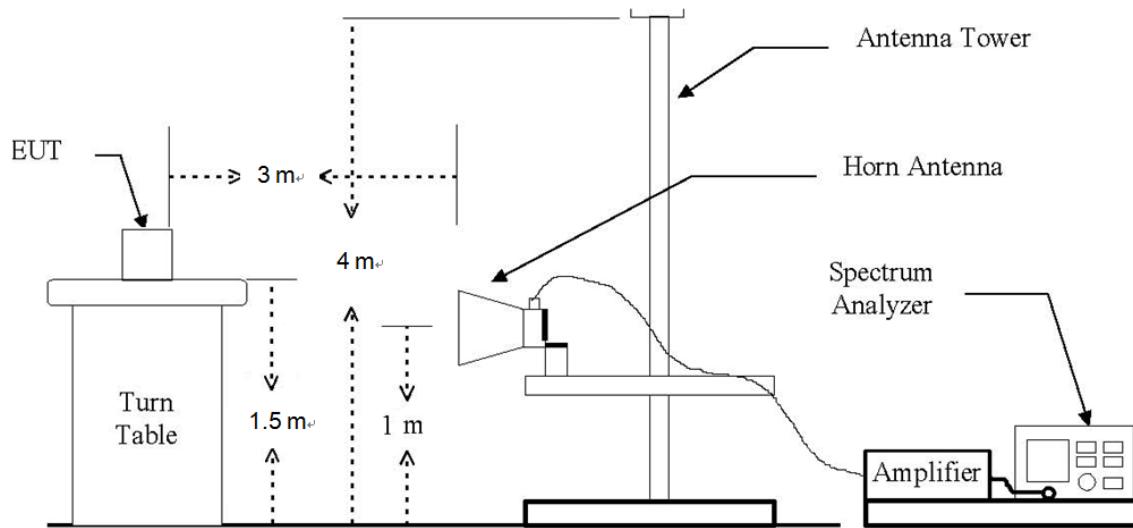


The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



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The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10th harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.



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2.2. Limit

2.2.1. Radiated emission limits, general requirements

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

2.2.2. Periodic operation in the band 40.66-40.70 MHz and above 70 MHz

In addition to the provisions of Section 15.205, the field strength of emissions from intentional radiators operated under this Section shall not exceed the following:

Fundamental Frequency (MHz)	Field Strength of Fundamental (microvolts/meter)	Field Strength of Spurious Emissions (microvolts/meter)
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	¹ 1,250 to 3,750	¹ 125 to 375
174 - 260	3,750	375
260 - 470	¹ 3,750 to 12,500	¹ 375 to 1,250
Above 470	12,500	1,250

¹Linear interpolations.

Where F is the frequency in MHz, the formulas for calculating the maximum permitted fundamental field strengths are as follows : for the band 130-174 MHz, $\mu\text{V}/\text{m}$ at 3 meters = $56.81818(F)-6136.3636$; for the band 260-470 MHz, $\mu\text{V}/\text{m}$ at 3 meters = $41.6667(F)-7083.3333$. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

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2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2009.

Remark:

Testing for radiated emissions above 1 GHz was performed with the EUT elevated at 1.5 m instead of 0.8 m. 1.5 m is the required height in ANSI C63.10:2013 as referenced by RSS GEN issue 4. This test height has been permitted by FCC as discussed in FCC-TCB conference call in December 2014.

2.3.1. Test Procedures for emission below 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
- c. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- d. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

2.3.2. Test Procedures for emission from 30 MHz to 1 000 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
- c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

2.3.3. Test Procedures for emission above 1 GHz

- a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.

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2.4. Test Result

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

The following table shows the highest levels of radiated emissions on one of the polarizations of horizontal and vertical.

Freq. (MHz)	Detector	Ant. Pol.	Reading (dB μ N)	Antenna Factor (dB)	Cable Loss (dB)	Result (dB μ N/m)	Limit (dB μ N/m)	Margin (dB)
433.96	Peak	V	63.10	17.12	3.60	83.82	100.83	17.01
433.96	Average	V	55.87	17.12	3.60	76.59	80.83	4.24

Remark:

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-axis. Worst case is Z-axis.

Definition of DUT for three orthogonal planes is described in the test setup photo.

Note:

1. 3 m Limit (dB μ N/m) = $20\log[41.6667(F_{(MHz)})-7083.3333] = 80.83$
2. Correction Factor = Antenna Factor + Cable Loss
3. Average Reading = Peak Reading + Duty Cycle Correction Factor
4. Duty Cycle Correction Factor : $20\log(Tx_{on} / 100 \text{ ms}) = 20\log(43.48/100) = -7.23$
 - Tx_{on} time = 43.48 ms
 - Tx_{on+off} time = 100.00 ms (pulse train is 100 ms instead of 163.77 ms)

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3. Spurious Emission

3.1. Test Setup

Same as section 2.1. of this report.

3.2. Limit

Same as section 2.2. of this report.

3.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2009.

3.3.1. Test Procedures for emission below 30 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
- c. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- d. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

3.3.2. Test Procedures for emission from 30 MHz to 1 000 MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
- c. The antenna is a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

3.3.3. Test Procedures for emission above 1 GHz

- a. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 MHz for Peak detection and frequency above 1 GHz.

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3.4. Test Result

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

The following table shows the highest levels of radiated emissions on one of the polarizations of horizontal and vertical.

The frequency spectrum from 13.56 MHz to 4 500.00 MHz was investigated.

Radiated Emissions			Ant	Correction Factors		Total	FCC Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	Amp Gain +CL (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
*1 301.97	55.00	Peak	V	25.17	-37.77	42.40	74.00	31.60
*1 301.97	47.77	Average	V	25.17	-37.77	35.17	54.00	18.83
1 735.82	65.79	Peak	V	26.94	-36.71	56.02	80.83	24.81
1 735.82	58.56	Average	V	26.94	-36.71	48.79	60.83	12.04
*3 904.90	44.64	Peak	H	32.37	-33.51	43.50	74.00	30.50
*3 904.90	37.41	Average	H	32.37	-33.51	36.27	54.00	17.73
Above 4 000.00	Not detected	-	-	-	-	-	-	-

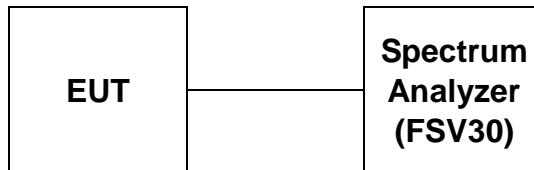
Remark:

1. "*" means the restricted band.
2. To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-axis. Worst Case is Z-axis.
3. Definition of DUT for three orthogonal planes is described in the test setup photo.
4. 3 m Limit (dB μ V/m) = $20\log[41.6667(F_{\text{MHz}})-7083.3333] - 20$ dB μ V/m = 60.83 dB μ V/m
5. Correction Factor = AF + Amp Gain + CL
6. Spurious Emission test results meet both peak and average limit.
7. The device has a reference clock operating 13.56 MHz.
8. The device has a reference clock operating 13.56 MHz.
9. Average Reading = Peak Reading + Duty Cycle Correction Factor
10. Duty Cycle Correction Factor : $20\log(T_{\text{on}}/100 \text{ ms}) = 20\log(43.48/100) = -7.23$
- T_{on} time = 43.48 ms
- $T_{\text{on+off}}$ time = 100.00 ms (pulse train is 100 ms instead of 163.77 ms)
11. According to § 15.31(o), the amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this report.

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4. Bandwidth of Operation Frequency

4.1. Test Setup



4.2. Limit

The bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

4.3. Test Procedure

1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 10 kHz, VBW = 10 kHz and Span = 1 MHz.
3. The bandwidth of fundamental frequency was measured and recorded.

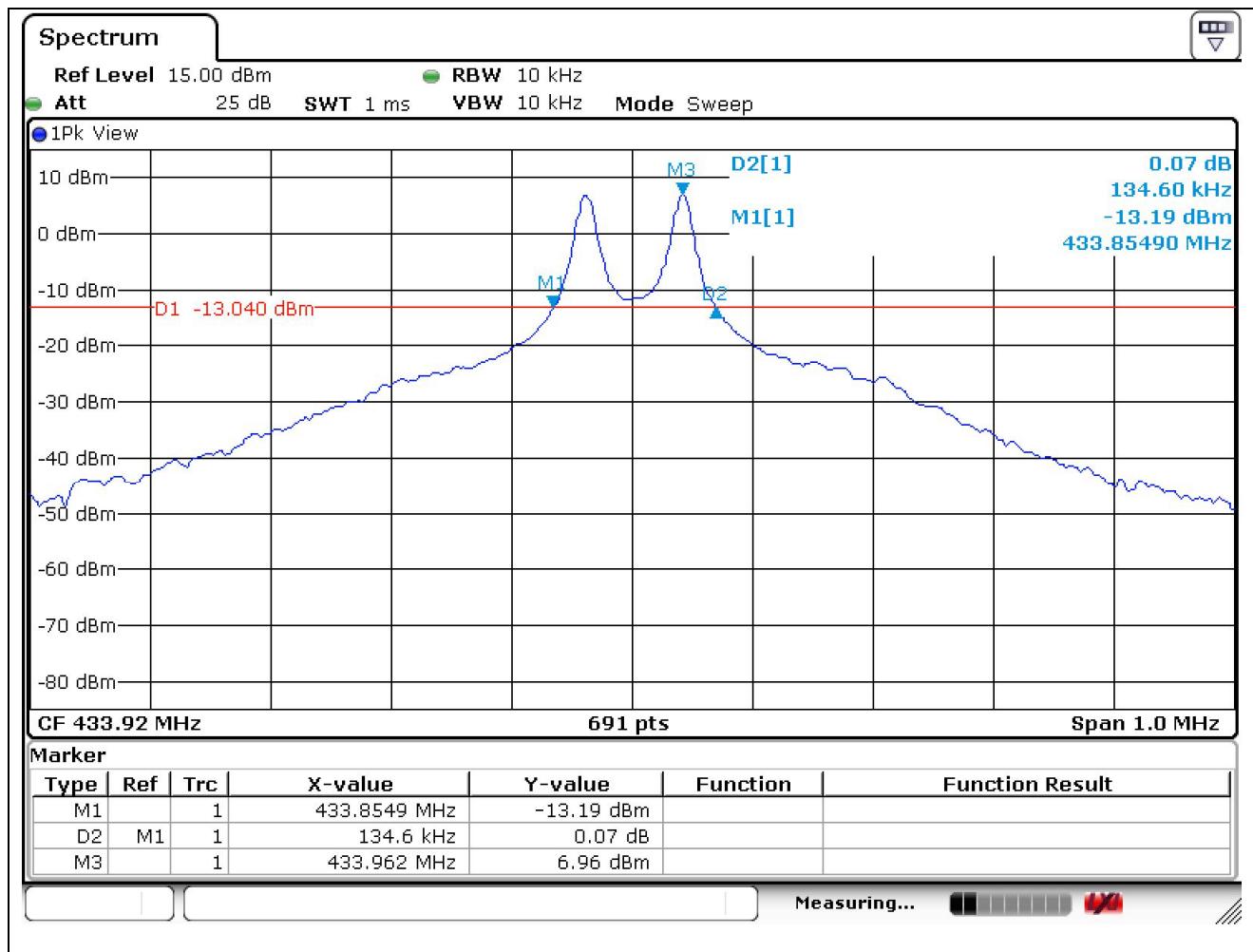
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4.4. Test Result

Ambient temperature : (23 ± 1) °C

Relative humidity : 47 % R.H.

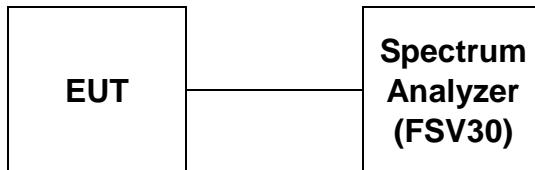
Carrier Frequency (MHz)	Bandwidth of the emission (kHz)	Limit (kHz)	Remark
433.92	134.60	1 084.80	The point 20 dB down from the modulated carrier



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5. Transmission Time

5.1. Test Setup



5.2. Limit

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

5.3. Test Procedure

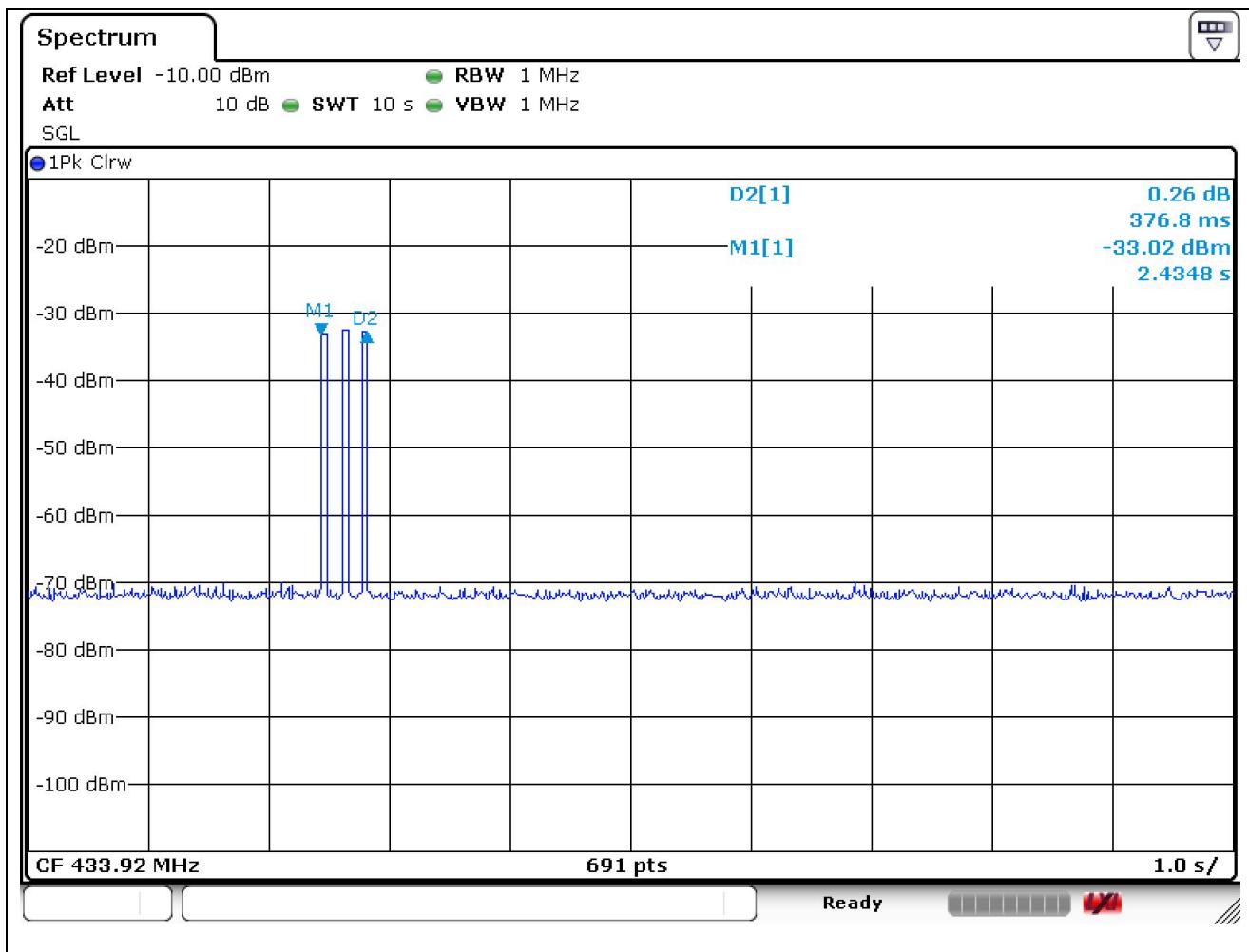
1. The transmitter output is connected to the spectrum analyzer.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 1 MHz, VBW = 1 MHz, Span = 0 Hz, Sweep Time = 10 sec.
3. The bandwidth of fundamental frequency was measured and recorded.

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5.4. Test Result

Ambient temperature : (23 ± 1) °C
Relative humidity : 47 % R.H.

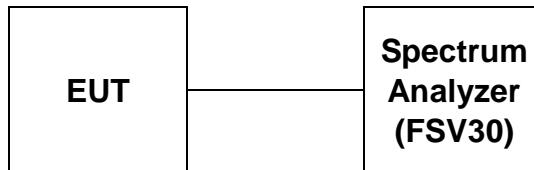
Carrier Frequency (MHz)	Transmission Time (sec)	Limit (sec)	Remark
433.92	0.38	Same or less than 5 s	Pass



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6. Duty Cycle Correction Factor

6.1. Test Setup



6.2. Limit

Nil (No dedicated Limit specified in the Rules)

6.3. Test Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW = 1 MHz, VBW = 1 MHz, Span = 0 Hz, Sweep Time = 500 ms.

6.4. Test Result

Ambient temperature : (23 ± 1) °C
Relative humidity : 47 % R.H.

CALCULATION :

Average Reading = Peak Reading (dB μ V/m) + 20log(Duty Cycle)

In order to determine possible Maximum Modulation percentage, alterations are made to the EUT.
We measured :

T _{on+off}	T _{on}	M % = (T _{on} / T _{on+off}) * 100 %	Duty Correction Factor
100 ms	43.48 ms	43.48	-7.23

T_{on+off} = 100 ms

T_{on} = 43.48 ms

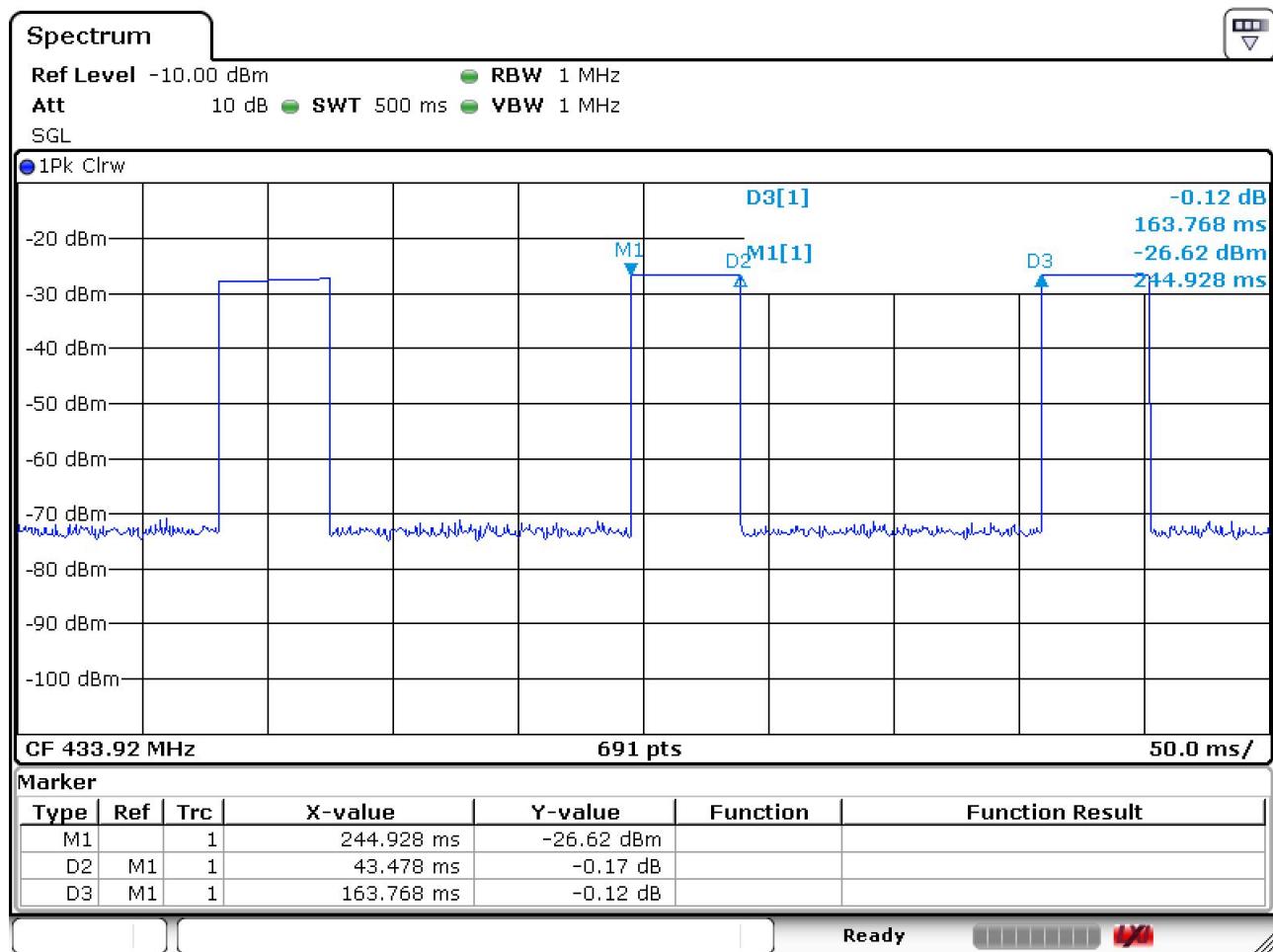
Duty Cycle = 20log(T_{on} / T_{on+off}) = 20log(0.4348) = -7.23

Remark:

1. T_{on+off} > 100 ms. Use 100 ms for calculation

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6.5. Test Plot



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